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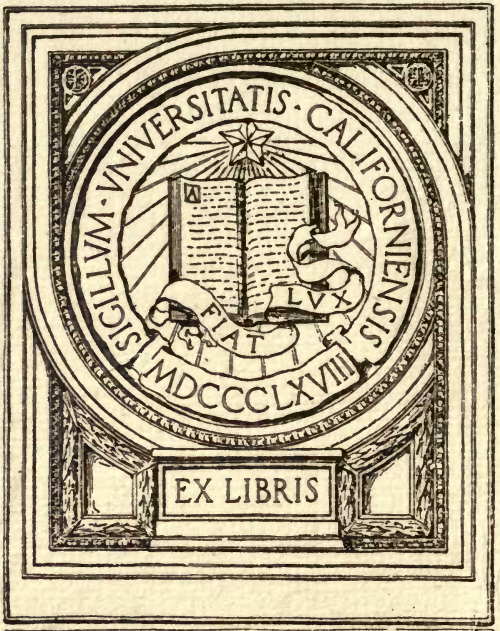
MARINE BAROMETER
IN AMERICAN WATERS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DEVELOPMENT OF THE MARINE BAROMETER IN AMERICAN WATERS

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Are There Equinoctial Storms?

THE severe West Indian storms occurring about the time of the spring and autumnal equinoxes have long been the subject of investigation, and the early opinions have been handed down to the present time with many other sayings, like the St. Swithins Day fallacy, from the days of superstition and comparative ignorance of the sciences. They are with us to some extent even at this day, but not of so marked a character nor so broadcast as they were even fifty years ago. They cannot stand the searchlight of investigation, nor the analysis of these storms to a locality at or near the time of the equinoxes, for a long period of years.

Our early education on this subject has no doubt been the reason for entertaining opinions held for so many years. Being handed down from one generation to another with but little thought of their causes, the subject engaged the attention of very few. The "equinoctial gales," so called, were then accepted and recognized as regular visitors to our sea coast cities at stated intervals of the spring and autumn of the year.

That they were a factor then to be recognized and taken into account and that had a firm hold on public opinion in this country can be brought to mind by some persons even at this late day. When preparing to start on a deep sea voyage near the spring or autumn equinox they would be advised that it were more prudent to wait until the equinoctial had passed before sailing, on account of the danger to a vessel running into one of these storms.

Some of the popular sources of information in former days may be quoted from as showing the opinions then entertained on the subject by those well informed. Thus Universal Etymological English Dictionary of 1764 says, "Hurricane; a violent form of wind which often happens in the East and West Indies in September and October, overthrowing trees, houses, and whatsoever is in its way." Hurricanes begin in the North, but turn around, and in a little time veer through all the points of the compass. Dictionary of the English Language, Samuel Johnson, 1768, "Equinoctial Wind" happening about the time of the equinoxes. Falconer's Naval Dictionary, 1804, "Equinoctial Gales"; storms which are observed

generally to take place about the time of the Sun's crossing the equator or equinoctial line, at which time there is equal day and night throughout the world. Mariner's Dictionary or American Seamen's Vocabulary of Technical Terms and Sea Phrases, 1805, "Equinoctial Gales," storms which are observed generally to take place about the time of the Sun's crossing the equator or equinoctial line, at which time there is equal day and night throughout the world; "Hurricanes," a violent and prodigious tempest accompanied with lightning, in which the wind blows from every part of the compass, causing a dangerous agitation in the sea, when the waves break and dash against each other with astonishing fury. Hurricanes are most frequent between the tropics, when they sometimes produce the greatest devastation. They generally take place about the time of the Sun's passing the equinox, i. e., the 21st March and 21st September. Noah Webster in his American Dictionary of 1828 says: "Pertaining to the time when the Sun enters the equinoctial point, as an equinoctial gale or storm, which happens at or near the equinox in any part of the world." In New York daily

newspapers we find the severe storm of September, 1815 reported as "the equinoctial gale." It appears to have extended near the whole length of our eastern seaboard. In September, 1838, "We had throughout yesterday one of the steady, soaking, Northeast rains, which usually precede or attend the autumnal equinox." In September, 1844, "After a dry spell of unusual duration * * * we had a slight shower on Saturday night last, which was succeeded yesterday by a settled rain from the Northeast, a genuine equinoctial, which promises to soak the earth before it ceases." In September, 1853, is recorded, "Wednesday night's gale may be considered as a prelude of the equinoctial storms which are generally attended with more or less disastrous effects." Even as late as 1882 there is stated, "The Equinoctial Storm." "If the storm of the past few days was not the traditional line storm which the scientists inform us does not exist, but which nevertheless appears at just about this portion of the present month, it resembled the genuine article just as closely as was desirable." Of a more recent date there is found "Equinoctial Weather." Though the autumnal equinox is almost due there is no

distinct signs just now of any general equinoctial storm. * * * Vessels now sailing to southern ports should therefore be prepared to encounter dangerous cyclones advancing from West Indian waters, which may be expected before the close of this month." * * * Gave the Atlantic seaboard from Florida to New York quite an equinoctial storm."

We thus see that the same popular opinion of the equinoctial storm was entertained in this country for more than one hundred years, and to a very recent date. There have been so very few of these severe storms in the vicinity of New York City, of a pronounced character, about the time of the spring or autumnal equinox of late years, that it is somewhat difficult to say how much of a hold the old theory has at the present day. There is some left no doubt.

Benjamin Franklin was the first in this country to note the course and severity of these Northeast storms on our coast. In a letter dated at Philadelphia, Pa., July 16th, 1747, he said on the subject: "We have frequently along this North American coast storms from the Northeast which blow violently. Some-

times three or four days. Of these I have had a very singular opinion some years, viz.: that though the course of the wind is from Northeast to Southwest, yet the course of the storm is from Southwest to Northeast; that is, the air is in violent motion in Virginia before it moves in Connecticut, and in Connecticut before it moves at Cape Sable." The one storm of which he left a partial record occurred in latter part of October, 1743. There was a map of Pennsylvania, New Jersey, and New York published in 1749 by Louis Evans that contained a memorandum: "All our great storms begin to leeward; thus a Northeast storm shall be a day sooner in Virginia than Boston." This was the extent of our knowledge of these Northeast storms on our coast for many years. The scattered population along our seaboard, the small number of persons who had any knowledge whatever of the subject, and the very few meteorological instruments in the country at the time, made any inquiry into the causes of these storms a very difficult study. After 1820, when the population along our Atlantic coast was very much greater, and they had largely recovered from the embarrassed finan-

cial condition arising from the Revolutionary War and the War of 1812-14, there were a few who were given to researches into questions of science, and among them was William C. Redfield, of New York City. In a paper written by him in January, 1831, he gave his theory of the causes and movements of the storms of the Atlantic Ocean; this was entirely new at the time, but his theory has held good to this day. He was in the front rank of the scientists of that period, and at the time of his paper on these storms was engaged in steam navigation in New York waters, and was among the first to adopt the use of the compound engine in steam vessels in this country.

That the old theory on this subject has not been entirely laid aside, it may be stated that a known scientist not many years ago said he "felt rather unhappy at the overthrow of the old-fashioned theory with regard to the equinoctial gales, and that he could not quite consent to its burial in spite of the overwhelming evidence brought forward." Another scientist referring to the source of this old theory of the equinoctial gales said, "If they could look back into old Italian or Roman

history they would find that severe gales had occurred about the equinoxes, which perhaps had buried their fleets by hundreds at a time, and that the memory of these disasters had lived long in popular memory in Italy."

The term "Equinoctial Gale" has of later years been used as describing a gale or severe storm on our Atlantic coast occurring within seven days either side of the spring or autumnal equinox.

To make an analysis of the atmospheric conditions at one locality on our Atlantic coast for an extended period, the writer has prepared two charts from the records of the U. S. Weather Bureau at New York City of the daily precipitation for 21 days, ten days either side of the spring and autumnal equinox, one chart for March 20 and the other for September 20, and covering a period of 40 years from 1871 to 1910 inclusive. The records of the Meteorological Observatory at New York City covering the same period, and in the same form have also been prepared.

In a comparison of the records of the two stations it is found that the total rainfall for the 40 years from March 10 to March 30 in-

clusive at the U. S. Weather Bureau was 108.5 inches, and for the same period at the Meteorological Observatory was 104.24 inches, a difference for the 40 years of 4.26 inches, due no doubt to difference in location of the instruments. Then in a comparison of the fall period, it is found at the U. S. Weather Bureau the total precipitation has been for the same length of time during September 112 inches, and at the Meteorological Observatory 114.24 inches. We thus see there was for the period of 21 days during 40 years an increase of precipitation during the fall over the spring period.

Divided into periods of 10 years each for the twenty-one days the U. S. Weather Bureau record shows the

first ten years in March a precipitation of 32.05 inches;

second ten years in March a precipitation of 29.17 inches;

third ten years in March a precipitation of 26.88 inches;

fourth ten years in March a precipitation of 20.4 inches.

The Meteorological Observatory record shows for the same period:

first ten years a precipitation of 33.91 inches;

second ten years a precipitation of 25.82 inches;

third ten years a precipitation of 23.37 inches;

fourth ten years a precipitation of 21.14 inches.

For the September division the records of the U. S. Weather Bureau show

first ten years a precipitation of 25.09 inches;

second ten years a precipitation of 42.94 inches;

third ten years a precipitation of 18.04 inches;

fourth ten years a precipitation of 25.93 inches.

The Meteorological Observatory records show

first ten years a precipitation of 25.75 inches;

second ten years a precipitation of 40.57 inches;

third ten years a precipitation of 19.47 inches;
fourth ten years a precipitation of 28.45 inches.

This shows that the ten years from 1881 to 1890 inclusive in September there was the greatest precipitation, and that from 1891 to 1900 there was the least precipitation. So the September period shows a wider range of rainfall in ten year divisions than does the March period.

Of the individual storms, of which thirty-four in all have been taken notice of, those within seven days before and seven days after the 20th of March would be of interest; that of March 21st, 1871, where there was a rainfall of 2.3 inches, with maximum wind velocity of 13 miles per hour. On March 20 and 21, 1876, a rainfall of 2.5 inches with Northeast wind of 41 miles maximum velocity, and on March 25 a precipitation of 3.6 inches. March 26-27, 1877, a rainfall of 2.97 inches with a maximum wind velocity of 26 miles. March 19-20, 1881, a rainfall of 2.64 inches with Northeast wind of 27 miles maximum. March 21, 1886, precipitation of 1.5 inches with wind velocity of 36 miles.

March 22, 1899, precipitation of 1.5 inches, wind velocity 30 miles. March 19, 1906, rainfall of 1.4 inches, maximum wind velocity 22 miles. March 25, 1909, a rainfall of 1.63 inches with wind velocity 18 miles per hour.

The total rainfall by records of U. S. Weather Bureau for 40 years on 7 days preceding the 20th of March was 36.67 inches, and for the 7 days succeeding the same date was 40.73 inches. Of those fourteen days named the greatest precipitation on any one day for forty years was March 21 of 12.31 inches, and the least for the same time was on March 24 of 1.35 inches. That shows a very wide range of rainfall for such a long period of time. The day of equinoctial interest, the 20th, stands forth as second from the bottom of the list, with only a total of 2.97 inches in 40 years; the Meteorological Observatory record gives this date 4.5 inches, and for the last ten years on this same date there has been a total precipitation of only .16 of an inch. If there is any one day to which a ray of hope may be attached to build the old theory upon in the month of March it will be either the 19th or the 21st of that month. Of

the former for 40 years there was a total precipitation of 10.22 inches in 22 years, 16 years with no rain, and 2 years with a trace of rain, and in the last ten years there were four years with no rain. On the 21st there was a total rainfall of 12.31 inches in 18 years, 4 years a trace of rain, and 18 years no rain, and in the last ten years there were six years with no rain. While the record of the Meteorological Observatory for these dates do not in every instance agree with those given, still the result is by no means affected, in fact it makes the old theory equally unstable.

Taking the individual storms for the September period under the same conditions as those named for the March period we find that of September 16-18, 1874, a rainfall of 5.67 inches and wind velocity of 13 miles: Meteorological Observatory records 7.09 inches. In 1882, September 20-23, a rainfall of 9.21 inches; Meteorological Observatory 12.12 inches, wind velocity, maximum Northeast, 23 miles. In 1890 a precipitation of 6.29 inches, maximum wind velocity Southeast, 24 miles; Meteorological Observatory record, 3.21 inches, wind 8 miles. In 1894 on September 17-19, rainfall 5.81 inches,

wind velocity 14 miles. In 1903 on September 16-17, 2 inches precipitation, East wind, maximum velocity 63 miles per hour. In 1904 on September 14-15 a rainfall of 2.91 inches, wind Northeast, 22 miles. In 1907, on September 21-23, a precipitation of 3.16 inches, Northeast wind, 11 miles.

The heavier precipitation in September than during March period can be accounted for in the continuation of the summer temperature, for during the whole month of September for 39 years there were 17 years when the daily maximum temperature of the atmosphere exceeded 85°, and ten years 90° and over, and one year, in 1881, when it reached 100°. Many of the storms during this high temperature were accompanied by thunder and lightning, and were of such short duration as to be unlike the traditional equinoctial storm. There were a succession of these storms in this month that might be mentioned, as showing its large rainfall and its limited area, that occurred on September 15-16-17, 1890. The September period also shows that the 17th of that month heads the list with a total precipitation in 40 years of 11.17 inches by records U. S. Weather

Bureau, and by those of the Meteorological Observatory 12.37 inches, and during that time there were 15 days with rain, 22 days no rain and 3 days with a trace of rain, and in last ten years were 4 years .89 inches, and 6 years no rain. The 23rd of same month has a total precipitation of 10.06 inches, Meteorological Observatory 12.23 inches: 11 days with rain and 29 days no rain. The 20th of the month shows for the same time a precipitation of but 2.72 inches, while the seven days succeeding the same date show an average per date of 4.35 inches.

Of the 21 day period for 40 years, having 840 days, there were in March 421 days when there was no rain, not even a trace; and in September for the same period there were 502 days with no rain. Of the period of 7 days before and 7 days after the 20th, that for March shows 299 days without precipitation, and that for September 346 days with no rain, giving practically the same percentage of days with no rain in each period.

Greatest precipitation in any one day of 24 hours within the period in March was on March 25, 1876, of 4.25 inches by U. S. Weather Bureau,

and in September was on the 23rd, September, 1882, record of Meteorological Observatory 8.28 inches, and U. S. Weather Bureau 6.17 inches. Difference in time of making observations may have made the difference in the records.

As the well known blizzard of March, 1888, comes within the 21 day period under review, there was only the high velocity of the wind for such an extended time that gave it any resemblance to our severe Northeast storms, but the extreme low temperature of the air with the heavy snowfall, all combined, make it a subject of historical interest in meteorology. The snowfall was on Monday, the 12th of March, 16.5 inches; the 13th, 3 inches; the 14th, 1.4 inches; total for three days by official record, 20.9 inches; total in rain, including Sunday the 11th, 2.46 inches. Temperature:

	7.30 a. m.	3 p. m.	10 p. m.	Lowest.
11th Sunday	37°	38°	34°	
12th Monday	24°	17°	11°	10.7°
13th Tuesday	6°	12°	14°	4.8°
14th Wednesday..	23°	39°	34°	12.9°

Maximum wind velocity on the 11th, Northeast 21 miles at 10 p. m.; on the 12th, West, 48 miles

at 10 p. m.; on the 13th, West, 50 miles at 7 a. m.; and on the 14th, Northwest, 24 miles at 7 a. m.

It seems clear from an examination of the figures brought out through the analysis of the several charts that there is little, if any hold to fasten the old theory of the equinoctial storms upon. Taking the very large percentage of the whole number of days, with March showing 50 per cent. of days with no rain, and September showing almost 60 per cent. of days having no rain, it would seem to be conclusive evidence that the old theory of equinoctial storms being always present 7 days before or 7 days after the spring or fall equinox would no longer be held to be of any value. So the answer can well be given, taking counsel of the figures, to the question, are there equinoctial storms along our Atlantic coast about the time of the spring or autumnal equinox, that there *are not.*

Development of the

Marine Barometer

IN

American Waters

Development of the Marine Barometer in American Waters

EXPERIMENTAL STAGE. The mercurial barometer was the invention of Evangelista Torricelli, an Italian mathematician and philosopher, who was the successor of Galileo, of Florence, Italy. The latter had begun the experiments in 1642, but they were brought to a successful stage in 1643 by his successor. Its first experimental use was in ascertaining the heights of the elevated locations of the surfaces of the earth.

The barometer in its orginal form seems to have been used on vessels at an early date, as we find that another form of instrument was needed to overcome the violent oscillation of the mercury in the tube, due to the motion of the vessel, that made it unreliable.

It was some years before a barometer for marine purposes was brought into use, and then not in the form of the mercurial instrument. The earliest marine barometer of which there appears to be any record was that of the invention of Dr. Robert Hooke, of Great Britain, in

1668. This instrument is thus described in the year 1700: "It consists of two thermometers, one air and one spirit of wine on the same frame. They each have their own scale at the side of their tubes that were graduated to their own use. The observation was made by a comparison of the state of the air thermometer with the spirit thermometer." This instrument, while strictly not a barometer, was one that indicated the changed conditions of the atmosphere. Dr. Edmund Halley, the British astronomer, in his voyage to the South Seas in 1700 to study the variation of the compass, and attempt the discovery of what land lay to the south of the western ocean, had one of these instruments with him, and he said: "It never failed to prognosticate and give early notice of all the bad weather we had, so that I depended thereon and made provision accordingly, and from my own experience I conclude that a more useful contrivance has not for this long time been offered for the benefit of navigation."

There now passed many years, during which the portable mercurial barometer was passing through many changes and taking different forms; otherwise it was in an active experi-

mental stage. Whether there were any marine mercurial barometers in use during this period it is difficult to say.

The earliest record we have of the mercurial marine barometer was of one in the expedition under Capt. John C. Phipps, of the British navy, who sailed in 1773 with two vessels to find the northern route to India via the North Pole, but was unsuccessful from the sea being blocked with ice. Among the many instruments sent out in the expedition was a mercurial barometer made by Nairne of London, who thus describes the instrument: "The bore of the upper part of the glass tube of this barometer is about 3/10 inch diameter and 4 inches long. To this is joined a glass tube with a bore about 1/20 inch diameter. The two glass tubes being joined together form the tube of this barometer, and being filled and inverted into a cistern of the same the mercury falls down in the tube till it is counterbalanced by the weight of the atmosphere. In a common barometer the motion of the mercury up and down in the tube is so great at sea that it is not possible to measure its perpendicular height, consequently cannot show the alteration in the

weight of the atmosphere, but in this marine barometer that defect is remedied. The instrument is fixed in gimbals and kept in a perpendicular position by a weight fastened to the bottom of it. The perpendicular rising and falling of the mercury is measured by divisions on a plate divided into inches and tenths, and a vernier division into hundredths of an inch which is fixed to the side of the tube."

We are now brought to a period but a few years from the opening of our War of the Revolution, and see that the only marine barometers of which we have any record were those carried on scientific expeditions. There may have been some in use on merchant vessels at this period in foreign waters and no doubt were, but there were none on vessels in our own waters so far as the record shows.

BAROMETER IN MEDICAL SCIENCE.

The early use of the portable mercurial barometer in this country was by a Dr. John Lining, a physician at Charleston, S. C., in 1737, in connection with other meteorological instruments, to study the relation of diseases to the changes and influences of the weather. Most of those

persons making use of these instruments, for other purposes than as a novelty or a toy, were professional men connected with our colleges, scientific and medical societies. The Medical Bureau of the U. S. War Department, about 1820, took up the subject of weather observations to study the relations of diseases to the changes of the weather from a professional standpoint.

WEATHER GLASS. The type of marine barometer appears in doubt about the last of the 18th Century, for the term of "weather glass" was given to instruments, in some cases, used for the purposes of noting the changes of the atmosphere on a vessel. ***"Weather glass,"*** a glass that shows the change of weather, with degrees of heat and cold. ***"Barometer,"*** a machine for measuring the weight of the atmosphere in order chiefly to determine the changes of the weather. ***"Weather glass,"*** a barometer. ***"Marine barometer,"*** a double thermometer for convenience at sea. What was called the "Weather Glass" or "Storm Glass," and later known as the Camphor Glass, came into use about the same

period, and was described as follows: "An ingenious contrivance of this nature has lately been announced by Wiegler in Germany, and the invention of it is likewise claimed by Francis Anone of High Holborn. It consists of a glass tube containing a liquor that holds in solution a compound substance, the transparency or turbid appearance of which indicates the changes in the atmosphere. Thus if the weather promises to be fine the solid matter of the composition will settle at the bottom of the tube, while the liquor is pellucid. But previously to a change of rain the compound will gradually rise, the fluid will continue transparent, and small stars will be observed moving or floating about the glass. Twenty-four hours before a storm or very high wind the substance will be partly on the surface of the liquid apparently in the form of a leaf; the fluid in such a case will be turbid and in a state resembling fermentation. * * * Lastly, it may be ascertained from what point of the compass the wind blows by observing that the solid particles adhere more closely to the bottom on the side opposite to that from which the tempest happens to arise. This instrument has been

satisfactorily employed, both at sea and on shore, being small, portable, and tolerably exact, it may often serve as a substitute for the more bulky and expensive contrivances in common use." We thus see that the term "weather glass" covered most all types of marine barometers, and those not strictly a barometer; it was even used till not so many years ago in some cases.

MARINE BAROMETER IN UNITED STATES. In this country the first reference to the marine barometer we find is in the log book of the "Bon-Homme-Richard," of Commodore John Paul Jones' squadron, in 1779, where mention is made of the "breaking of the glass," but it does not appear what type of glass it was. This was the vessel fitted out by King Louis XVI. of France, and placed in the squadron of Commodore John Paul Jones during our War of the Revolution. As this vessel was fitted out at the time when France was well advanced in the arts and sciences, there may have been a mercurial barometer on board the vessel. It is stated that Commodore Perry had a barometer on Lake Erie during the War of

1812-14, and that Commodore McDonough had one on Lake Champlain during the same war, but no detail of type of instrument is given. The journal of Capt. David Porter, U. S. N., who made a cruise in 1812-13 to the Pacific Ocean in the frigate "Essex," shows the readings of the barometer and thermometer on board the vessel for a short period. We find also in the journal of Commodore Bainbridge, U. S. N., in the U. S. naval ship "Columbus" on her passage from Gibraltar to Boston, Mass., in June and July, 1821, a record for that period of the meteorological observations on board the vessel, including barometer readings, but there is no record of the type of the instruments.

During this period and for years later we fail to find any trace of a barometer of any type on board a merchant vessel of the United States, though it is not at all improbable that there were some instances where they were to be found. With the many packet ships that were plying between Great Britain, France, and the United States, carrying many immigrants, it would appear probable that there were some of the navigators of the American vessels that would become acquainted with the instrument

and its practicability while in the foreign ports, and have sufficient enterprise to obtain one, as an experiment, if nothing more. Probably one of the reasons for not adopting its use may have been, at least in some instances, that the officer or master in command of a vessel may have considered it a lowering of the dignity of the officer in command, for be it remembered they were great on the dignity of official position in those days, to have an instrument placed in their hands that should advise them of the coming changes in the atmosphere, their intimate knowledge of these very conditions gained through experience being one of the factors that gave them the command of the vessel.

That they had much to learn at this period, Clarence Dalrymple, captain of one of the East India Company's ships in 1832, mentions the use of the marine barometer as one reason of the short voyages between England and India. "A vessel may now make the voyage out and home in eight months, which fifty years ago required twelve months. Now by the use of this instrument, the observer, who follows its motions, may carry as much sail at night as by day, regarding also a principle of navigation to

brail up the sails in time before a squall, but to be prompt to spread all sail as soon as the chief violence of the storm has passed." An American marine authority in 1831, referring to the barometer, says: "It is somewhat singular that this instrument so useful for many purposes is not in more general use. The utility of them in affairs of navigation is unquestionable by those who have paid a little attention to them. No ship should be without one. It is true many ships have them, yet from the trifling observation bestowed upon them, they might as well be at the bottom of the sea."

About 1830 there came a change in our commercial and industrial affairs. Several new lines of packet ships were started to foreign ports, and between our coastwise cities; large numbers of skilled mechanics came to our cities from Europe on account of the labor troubles then existing at their former homes. It was the beginning of a commercial and mechanical development in this country, that showed its good results in a few years. Old methods and systems were being laid aside, younger men were coming into control and management of our business affairs, and the restless American

energy began to show itself. It took ten or more years to develop our renowned clipper ships and steamships. The new officers of our vessels brought advanced opinions that were more in line with the progress of the period, and by adopting one improvement with another were soon in the front rank of the navigators of the maritime world.

Prior to 1830 there was no system in our navy regarding the care of nautical instruments. When a naval vessel came into port from a cruise the instruments were taken ashore, stowed away, and small attention given them until they were again required for use. The first mention made of the care of nautical instruments in the U. S. Navy is in 1832, where Lieut. L. M. Goldsborough, U. S. N., was detailed "in charge of chronometers and nautical instruments," and located at Washington, D. C. That the barometer was one of the instruments in this bureau there is a record of the meteorological observations taken at this depot at this early date.

The earliest purchase of a marine barometer that can be found thus far in the navy records is in 1828, for a contemplated naval exploring

expedition to the South Seas and Pacific Ocean, that was not fitted out for several years. It included a Daniel's Standard barometer purchased in England, costing thirty-four dollars, and two mountain barometers purchased in New York that cost twenty-five dollars each. These instruments were in all probability part of the outfit that was placed on the U. S. Ship "Falmouth" that was sent on a voyage to the Pacific Ocean in 1831, and was the vessel Past Midshipman M. F. Maury, U. S. N., was on when he obtained his greatest knowledge of navigation, that in a few years brought him into such prominence in marine circles the world over. He wrote a paper that was published in 1834 in one of our scientific journals of that period, "On the Navigation of Cape Horn," in which he refers to the use of the barometer in the Southern latitudes. It is probably the most extensive paper on the subject at that early date. He says in part: "The result of my own barometrical observations compared with others to which I have had access, shows that within this region the barometer stands higher when the winds are from the westward than it does * * * between the same parallels in the Atlantic."

Prof. W. C. Redfield, the noted American meteorologist of this period, says of the barometer: "The great value of the barometer to navigators is becoming well understood, and its practical utility might be greatly increased by hourly entries of the precise height of the mercurial column in a table prepared for the purpose." A few years later the commander of one of our New York and Havre packets said: "When the ship was moving with high velocity, even the barometer could not indicate the current of air, for the ship would have moved beyond the influence of the wind which was indicated when the barometrical observation was taken." A criticism of this remark was made at the time, "that the want of a due attention to it is probably one of the causes which have aided to retard the more general use of this instrument among mariners. But by far the greatest cause which has prevented the universal use of the barometer is the difficulty of procuring a good one, and still greater difficulty of retaining it in perfect condition." It would seem as though many of our navigators at this period were in need of further experience with the barometer to get the best results, both in

their observations as well as the care of the instrument.

One of the officers of the U. S. Ship "Peacock" in 1835 refers to the barometer: "The barometer has not been in general use in the United States Navy more than fifteen or twenty years. This period is sufficient for establishing its utility in foretelling states of weather, but it has not yet gained the universal confidence of the officers. However certain the indications of this instrument may be on shore, where it is at perfect rest, and where the observations may be made with the nicest accuracy, the same cannot be said of it when at sea, where from the necessary motion of the ship in spite of the best mechanical contrivances for its suspension, the mercurial column is constantly fluctuating, and therefore the observations are obnoxious to error, and at best must be considered only as proximate to the truth." The U. S. Ship "Erie" made a voyage to Rio Janeiro from New York in 1837. During this passage of the vessel meteorological observations were taken on board showing use of the barometer, thermometer and hygrometer. "The barometer used for the purpose was a common marine barometer suspended in the large cabin of the ship."

The exploring expedition sent out to the Pacific Ocean in 1838 under Lieut. Charles Wilkes, U. S. N., was the first fitted out for purely scientific purposes in this country. The barometers on board the vessels are thus spoken of: "The barometer for the use of the Observatory was an ivory float gauge made by Troughton and Simms. Its diameter of tube was .35 of an inch. This was considered the standard. It continued in use throughout the voyage, and was in perfect order at the return of the expedition. There were four vessels in this expedition that had marine barometers, and one a sympiesometer. * * * The duty of keeping the meteorological journals on board the vessels was assigned to the medical officers of the expedition. The instruments used by the expedition were procured in 1836 from England, France, and Germany."

THE SYMPIESOMETER. The sympiesometer, formerly mentioned, was a form of sensitive barometer, of which there seems to be no former record of its use in this country. It was invented in 1816 by Alexander Adie, of

Edinburgh, Scotland, and is thus described: "The principle of the sympiesometer consists in measuring the weight of the atmosphere by the compression of a gaseous column. It consists of a glass tube about 18 inches long and 7 inches diameter inside, terminated above by a bulb closed at the top, and having the lower extremity bent upward and expanded into an oval cistern, open at the top. The bulb at the open extremity being filled with hydrogen gas, and a part of the cistern and tube with almond oil colored with anchusa root. The enclosed gas by changing its bulk according to the pressure of the atmosphere on the oil in the cistern, produces a corresponding elevation or depression of the oil in the tube, thereby indicating the variations in the weight of the atmosphere. The scale is made by comparison of the instrument with a standard." These instruments came into some use in American waters at a later date, and even after our Civil War there were some on vessels on our northern lakes. There were not many on the Atlantic coast.

WIND AND CURRENT CHARTS. With the reorganization of the U. S. Navy Department in 1842 came the establishment of the Depot of

Charts and Instruments, that was attached to the Bureau of Ordnance and Hydrography, that came under the charge of Lieut. Maury in 1844. This officer began his preliminary labors for the improvement of navigation in the same year, and during a lecture before the National Institute on the "Gulf Stream and Currents of the Sea," said in part: * * * "that all we know of this wonderful phenomenon is contained chiefly in what Dr. Franklin said of it more than fifty years ago. * * * In Dr. Franklin's time the navigator guessed as much as he calculated the place of his ship. Vessels from Europe to Boston frequently made New York, and thought the land fall by no means bad. Chronometers, now so accurate, were then an experiment. The instruments of navigation erred by degrees quite as much as they now do by minutes. Instances are numerous of vessels navigating the Atlantic in those times being 6°, 8°, and even 10° out of their reckoning in as many days from port. Our means, therefore, of properly conducting a system of observations upon the currents of the sea, and for following up the investigations of Franklin, are much more ample and complete than they have ever

been with navigators before. * * * The commercial marine of no country in the world can boast of shipmasters superior to the Americans as navigators, and in general intelligence. Their industry and enterprise warrant the expectation that they would join hands in the undertaking most readily. Personal knowledge of them warrants the belief that at the invitation of the Institute they would undertake a series of observations upon any plan the Society would propose." This was no doubt his first public appeal for aid in the cause of the Wind and Current Charts, that was later taken up by the Navy Department. His opinion of the Gulf Stream does not hold good at this day.

It was a radical step he had taken for that period, and one that did not meet with much encouragement and support at first from the American navigators, as they did not have the utmost confidence in our naval affairs. This prejudice was gradually overcome, and these charts were received by the commanders of deep sea vessels and a sufficient number of them returned in two years so that he was enabled to give navigators better sailing directions to some parts of the world than they had before. Direc-

tions to other parts of the world were given at a later period. These charts, as returned by the commander of the vessels, were "an abstract log of the daily position of the ship, of the prevailing direction of the wind for each of the three parts of the twenty-four hours, the height of the barometer, the state of the thermometer, and any remarks it might have occurred to them to make touching the winds and the waves, and the general course of navigation." These charts were the voluntary contribution by the shipmasters to the improvement of navigation. The first vessel to make use of Maury's Directions for Navigation is thus noted: "A bark from Baltimore, the 'W. H. D. C. Wright,' following his directions, made the voyage from that city to Rio and back in 85 days, including ten days' detention in foreign port. She passed to the south of Bermuda and made the passage to Rio in 38 days, following the great circle, and crossing the line the twenty-fourth day out in longitude 31° West." Maury said of this voyage, when on a visit to London in 1853. * * * "By the investigation of the subject of the winds on the outward and homeward routes he had discovered the space which he had before men-

tioned, and he concluded that in this space the winds were of the same in going out and coming home. Accordingly, he recommended vessels to take the middle or new route. The W. H. D. C. Wright, Jackson Master, was the first vessel that had the courage to take the new route. The average passage to the equator, being then 41 days, Captain Jackson made it in 24 days. He went to Rio and back in little more than the usual time occupied in going. This fact called the attention of navigators to the subject and enabled him to proceed with his investigations, and he soon had a volunteer corps of one thousand American ships, co-operating with him, in all parts of the ocean and furnishing him with the most valuable statistics." This voyage of the W. H. D. C. Wright was made in the spring of 1848. The Bark Ocean Bird, Captain T. A. Hall, from New York for San Francisco, in January, 1849, was among the first in collecting data for the Pacific Ocean, but the first of the navigators to the Pacific Ocean, under complete sailing directions to California, was Capt. McKay, with the clipper ship, "Sovereign of the Seas," from New York to San Francisco in November, 1852.

The value of these charts, as made by the shipmasters and returned to Lieut. Maury, who worked out better sailing directions for the navigator may be found in the letters to the writer of three of the old time American navigators, who have long since retired from service. Capt. R. G. F. Candage of Gleasondale, Mass., who was surveyor for Record of American and Foreign Shipping for more than 40 years, and the Bureau Veritas, at Boston, Mass., says of the barometer: "From my own knowledge it was in common use in the early 40's of the last century. I had one of the old style from 1850 to last February, when destroyed by fire with my house and contents, and my older brother had used it 8 or 10 years before 1850. In my sailor boy days back in the 40's all sea-going vessels that I sailed in carried a barometer.

"I kept for seven or eight years a log for Lieut. Maury, who was particular to have height of the barometer noted, temperature of the sea water, force and direction of the wind, form of clouds, condition of waves, weather, etc., from which data he constructed his sailing charts

and directions, one of the greatest benefits ever conferred on the American merchant marine of the Clipper Ship era, or since. In Maury's time the barometer was put to the uses above named in addition to former use as an indicator of gales or changes of weather." Capt. George A. Dearborn, of Gardiner, Maine, says in part: "The mercurial barometer was in use when he first went to sea as a sailor in 1840; does not know how long it was in use before that; the first Aneroid that he used was in 1853, when he was master. Lieut. Maury's work was a great help to masters of ships. He resigned his position after the war broke out, and was very much missed." Capt. S. F. Phillips says: "My first experience with a barometer was a mercurial, that commenced about 1845. At that time most of our ships that carried barometers were sailing ships. It was considered to be part of a master's working tools the same as our octant and charts, and went with the master. About 1850, when the building of steamers commenced, they were contracted for to be fitted for sea; that included instruments for navigation, and as the Aneroid barometer was the cheaper, it

was the one furnished by the contractors, consequently they came into general use."

In 1852 Lieut. Maury suggested to Great Britain the making of meteorological observations at sea, and invited the co-operation of the commercial, as well as the Naval Marine of all Maritime nations. It was not until 1853, after Lieut. Maury was at Brussels, as a delegate to the Marine Conference, held at that city, and had visited Great Britain on his way home, that the subject was taken up in a practical way by the Merchant Marine of that country, and the Wind and Current Charts adopted.

During the early days of the steam engine in the United States Navy it was the custom of the older officers, who were brought up in the service under different conditions to look upon the barometer on shipboard as one of those "new fangled things" that was placed on board the vessel more for show than service, but it was not long after the instrument had been generally adopted by the department before these officers began to see there were some good results to be obtained from its use, and in course of time relied upon it as their other nautical instruments.

ANEROID BAROMETER. The Aneroid barometer was first used by Prof. N. J. Conte, of Paris, in his balloon ascensions. He had found in his aerial work in 1795 that the Mercurial barometer was almost useless on account of the violent oscillation of the mercury in the tube, and he therefore, constructed a few years later an instrument somewhat in the shape of a watch, consisting of a bowl of iron upon which was a domed cover of very thin sheet steel, the joints made perfect; springs fitted in the bowl kept the cover at a proper elevation, from which the air was exhausted. The variations of the atmospheric pressure were indicated by means of a hand passing over a divided plate, and operated by suitable mechanism. This instrument was found on trial to be too sensitive to the changes of the atmosphere. There were a few Aneroid barometers of foreign manufacture that were on sale in this country many years later, but it was not until P. A. Fontaine Moreau obtained a patent on behalf of the inventor, Lucius Vidi, of Paris, in England, April 27, 1844, and in the United States, August 20, 1846, that this instrument was brought to a form for practical use. The patent says: "In

the application of thin sheets of metal or other flexible air tight substances to certain apparatus employed for measuring the pressure and elasticity of the air and other fluids." The first of these instruments we find any record of being on sale in this country was in the spring of 1849. There was another Metallic barometer that was brought into use in this country a few years later by a French inventor named Eugene Bourdon, who was widely known at this period for his then new pressure steam gauges and later Vacuum gauges, that were being introduced on our steam vessels. He was engaged in constructing tools and machinery for a railroad in France about 1840, and he was engaged in experiments with his pressure gauge prior to the invention of the Aneroid. The patent on his gauge was obtained in France, June 18, 1849, and in the United States, August 3, 1852. This gauge was described as made of a metal tube partially flattened in its length and coiled nearly to a circle; one end is closed up, while the other end is left open to receive the pressure of the steam. To the end that is closed a hand is fixed which indicates on a dial the variations of the pressure. By reversing the application

of the pressure a vacuum gauge was made. A barometer was made by exhausting the air from the coiled tube and hermetically sealing it."

After the expiration of the patent of Moreau the manufacture of Aneroid barometers was taken up by several makers, both for marine and land service, and was carried on for a comparatively few years, as improved instruments were being made in Europe and sold at prices with which the American manufacturers could not compete when quality was considered. During our Civil War there were numbers of these barometers fitted on the vessels of the blockading fleets on the coasts, and on the transports carrying supplies and munitions of war to the various supply depots of the Army and the Navy. Many of these instruments were made by Joseph T. Large, while the Bourdon type of Aneroid was furnished by other makers.

AMERICAN BAROMETERS. The early manufacture of Mercurial barometers in this country consisted of a few experiments prior to 1820. The main difficulty lay in the obtaining of a satisfactory glass tube for the instrument

that the domestic glass factories could not furnish for many years. There seems to be the best of reasons to believe that Marine barometers were not made in this country until after 1830, about which time so many skilled mechanics came to the United States. The first barometer exhibited at the American Institute fairs, for Marine use, was by John Roach, of New York, in 1835, and in 1839, Giuseppe Tagliabue, of New York, had a Marine baromter on exhibition at the fair, for which he was awarded a gold medal. For several years he was considered the maker of a high class of instruments. Another manufacturer of Marine barometers was Joseph T. Large, who had learned his trade with Giuseppe Tagliabue, and started in business for himself in New York in 1845. The nautical supply stores in our Maritime cities now began to an extent to patronize the home product. James Green was a maker of high-class instruments at an early date. In 1854 he devised the Mercurial barometer, adopted by the Smithsonian Institute, and later by the United States Signal Service, and Weather Bureau. He also made Marine barometers of a high grade for the U. S. Navy. There

are few Marine Mercurial barometers now made in this country, as the foreign production is sold at so low a figure.

At the present time the larger number of the vessels of our Merchant Marine have both the Mercurial and the Aneroid barometers in their equipment, as the latter being more sensitive to atmospheric changes gives an earlier indication of a coming change in the weather, but the former is still considered the standard instrument, but on account of trade conditions the foreign instrument is most generally used on our American vessels.